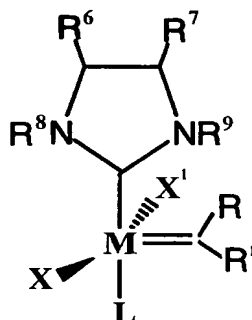


What is claimed is:

1. A compound of the formula



wherein:

M is ruthenium or osmium;
X and X¹ are each independently an anionic ligand;
L is a neutral electron donor ligand; and,
R, R¹, R⁶, R⁷, R⁸, and R⁹ are each independently hydrogen or a substituent selected from the group consisting of C₁-C₂₀ alkyl, C₂-C₂₀ alkenyl, C₂-C₂₀ alkynyl, aryl, C₁-C₂₀ carboxylate, C₁-C₂₀ alkoxy, C₂-C₂₀ alkenyloxy, C₂-C₂₀ alkynyloxy, aryloxy, C₂-C₂₀ alkoxycarbonyl, C₁-C₂₀ alkylthiol, aryl thiol, C₁-C₂₀ alkylsulfonyl and C₁-C₂₀ alkylsulfinyl, the substituent optionally substituted with one or more moieties selected from the group consisting of C₁-C₁₀ alkyl, C₁-C₁₀ alkoxy, aryl, and a functional group selected from the group consisting of hydroxyl, thiol, thioether, ketone, aldehyde, ester, ether, amine, imine, amide, nitro, carboxylic acid, disulfide, carbonate, isocyanate, carbodiimide, carboalkoxy, carbamate, and halogen.

2. The compound as in claim 1 wherein:

M is ruthenium;

L and L¹ are each independently selected from the group consisting of phosphine, sulfonated phosphine, phosphite, phosphinite, phosphonite, arsine, stibine, ether, amine, amide, imine, sulfoxide, carboxyl, nitrosyl, pyridine, and thioether; and,

X and X¹ are each independently hydrogen, halide, or a substituent selected from the group consisting of C₁-C₂₀ alkyl, aryl, C₁-C₂₀ alkoxide, aryloxide, C₃-C₂₀ alkyldiketonate, aryldiketonate, C₁-C₂₀ carboxylate, arylsulfonate, C₁-C₂₀ alkylsulfonate,

C₁-C₂₀ alkylthiol, aryl thiol, C₁-C₂₀ alkylsulfonyl, and C₁-C₂₀ alkylsulfinyl, the substituent optionally substituted with one or more moieties selected from the group consisting of C₁-C₁₀ alkyl, C₁-C₁₀ alkoxy, aryl and halide.

3. The compound as in claim 1 wherein:

M is ruthenium;

X and X¹ are each independently selected from the group consisting of halide, CF₃CO₂, CH₃CO₂, CFH₂CO₂, (CH₃)₃CO, (CF₃)₂(CH₃)CO, (CF₃)(CH₃)₂CO, PhO, MeO, EtO, tosylate, mesylate, and trifluoromethanesulfonate;

L is a phosphine of the formula PR³R⁴R⁵, where R³, R⁴, and R⁵ are each independently aryl, C₁-C₁₀ alkyl, or cycloalkyl;

R is hydrogen; and,

R¹ is phenyl or vinyl, optionally substituted with one or more moieties selected from the group consisting of C₁-C₅ alkyl, C₁-C₅ alkoxy, phenyl, and a functional group selected from the group consisting of hydroxyl, thiol, thioether, ketone, aldehyde, ester, ether, amine, imine, amide, nitro, carboxylic acid, disulfide, carbonate, isocyanate, carbodiimide, carboalkoxy, carbamate, and halogen.

4. The compound as in claim 3 wherein

X and X¹ are each chloride;

L is selected from the group consisting of -P(cyclohexyl)₃, -P(cyclopentyl)₃, -P(isopropyl)₃, and -P(phenyl)₃; and,

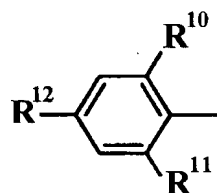
R¹ is phenyl or -C=C(CH₃)₂;

5. The compound as in claim 4 wherein R⁶ and R⁷ together form a cycloalkyl or an aryl.

6. The compound as in claim 4 wherein R⁶ and R⁷ together form a cyclopentyl or a cyclohexyl moiety.

7. The compound as in claim 4 wherein R⁶ and R⁷ are the same and are hydrogen or phenyl.

8. The compound as in claim 4 wherein R^8 and R^9 are each independently a substituted or unsubstituted aryl.
9. The compound as in claim 4 wherein R^8 and R^9 are the same and are phenyl.
10. The compound as in claim 4 wherein R^8 and R^9 are each independently of the formula

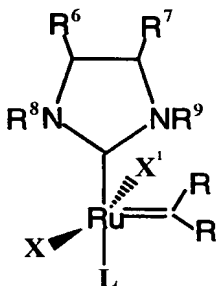


wherein

R^{10} , R^{11} , and R^{12} are each independently hydrogen, C_1 - C_{10} alkyl, C_1 - C_{10} alkoxy, aryl, or a functional group selected from hydroxyl, thiol, thioether, ketone, aldehyde, ester, ether, amine, imine, amide, nitro, carboxylic acid, disulfide, carbonate, isocyanate, carbodiimide, carboalkoxy, carbamate, and halogen.

11. The compound as in claim 10 wherein R^{10} , R^{11} , and R^{12} are each independently hydrogen, methyl or isopropyl.

12. A compound of the formula



wherein:

X and X^1 are each chloride;

L is selected from the group consisting of $-P(\text{cyclohexyl})_3$, $-P(\text{cyclopentyl})_3$, $-P(\text{isopropyl})_3$, and $-P(\text{phenyl})_3$;

R is hydrogen;

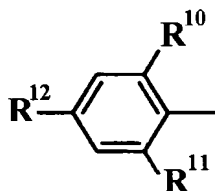
R^1 is phenyl or vinyl, optionally substituted with one or more moieties selected from the group consisting of C_1 - C_5 alkyl, C_1 - C_5 alkoxy, phenyl, and a functional group selected from the group consisting of hydroxyl, thiol, thioether, ketone, aldehyde, ester, ether, amine, imine, amide, nitro, carboxylic acid, disulfide, carbonate, isocyanate, carbodiimide, carboalkoxy, carbamate, and halogen;

R^6 and R^7 are each independently hydrogen, phenyl, or together form a cycloalkyl or an aryl optionally substituted with one or more moieties selected from the group consisting of C_1 - C_{10} alkyl, C_1 - C_{10} alkoxy, aryl, and a functional group selected from the group consisting of hydroxyl, thiol, thioether, ketone, aldehyde, ester, ether, amine, imine, amide, nitro, carboxylic acid, disulfide, carbonate, isocyanate, carbodiimide, carboalkoxy, carbamate, and halogen; and

R^8 and R^9 are each is independently C_1 - C_{10} alkyl or aryl optionally substituted with C_1 - C_5 alkyl, C_1 - C_5 alkoxy, aryl, and a functional group selected from the group consisting of hydroxyl, thiol, thioether, ketone, aldehyde, ester, ether, amine, imine, amide, nitro, carboxylic acid, disulfide, carbonate, isocyanate, carbodiimide, carboalkoxy, carbamate, and halogen.

13. The compound as in claim 12 wherein R^8 and R^9 are each is independently a cycloalkyl or a phenyl optionally substituted with C_1 - C_5 alkyl, C_1 - C_5 alkoxy, or halogen.

14. The compound as in claim 12 wherein R^8 and R^9 are each independently of the formula

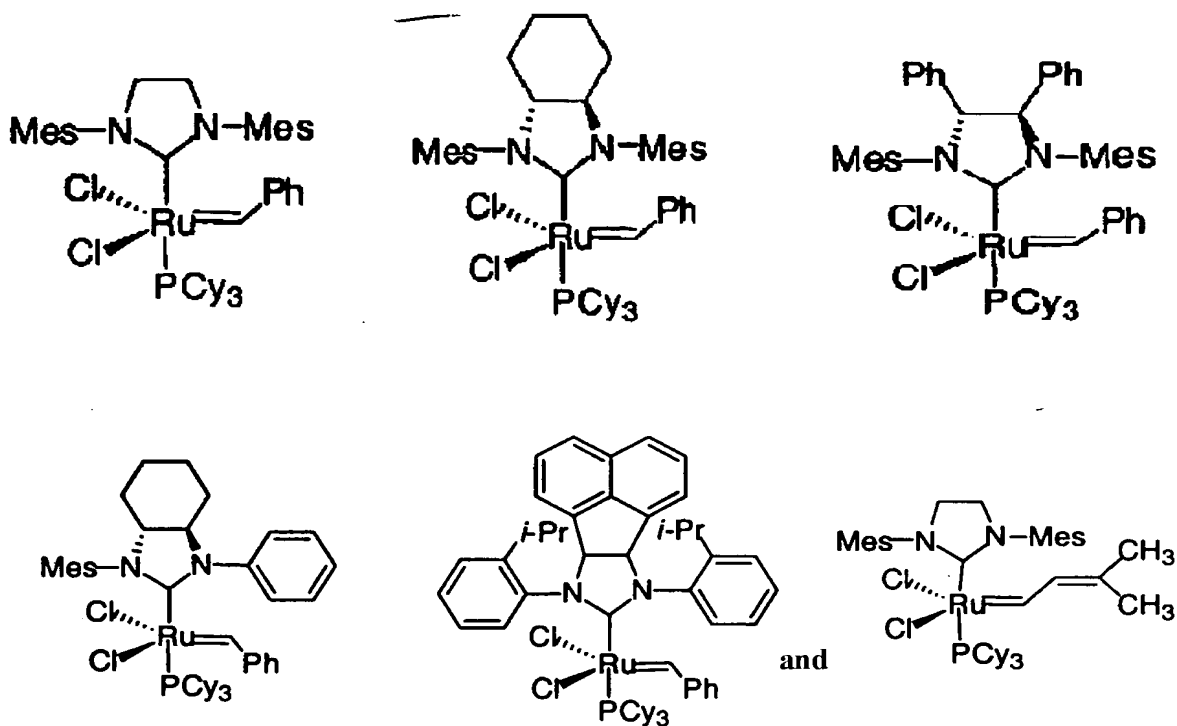


wherein

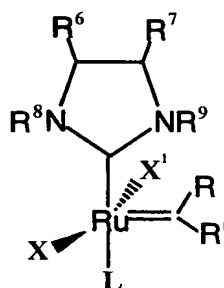
R^{10} , R^{11} , and R^{12} are each independently hydrogen, C_1 - C_{10} alkyl, C_1 - C_{10} alkoxy, aryl, or a functional group selected from hydroxyl, thiol, thioether, ketone, aldehyde, ester, ether, amine, imine, amide, nitro, carboxylic acid, disulfide, carbonate, isocyanate, carbodiimide, carboalkoxy, carbamate, and halogen.

15. The compound as in claim 14 wherein R^{10} , R^{11} , and R^{12} are the same and are each methyl.

16. The compound as in claim 12 selected from the group consisting of



17. A compound of the formula

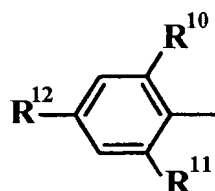


wherein:

X and X^1 are each chloride;

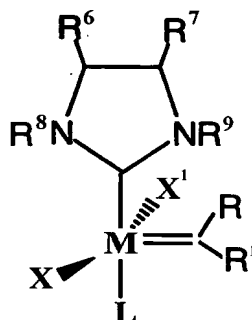
L is selected from the group consisting of $-P(\text{cyclohexyl})_3$, $-P(\text{cyclopentyl})_3$, $-P(\text{isopropyl})_3$, and $-P(\text{phenyl})_3$;

R is hydrogen;
R¹ is phenyl or -C=C(CH₃)₂;
R⁶ and R⁷ are each independently hydrogen, phenyl, or together form a cyclopentyl or cyclohexyl; and
R⁸ and R⁹ are each is independently of the formula

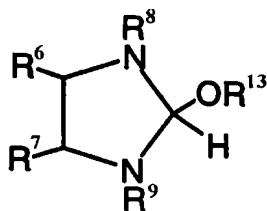


wherein
R¹⁰, R¹¹, and R¹² are each independently hydrogen, methyl, ethyl, propyl, isopropyl, hydroxyl, and halogen.

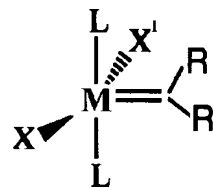
18. A method for making a compound of the formula



comprising contacting



with



wherein:

M is ruthenium or osmium;
X and X¹ are each independently an anionic ligand;
L is a neutral electron donor ligand;
R, R¹, R⁶, R⁷, R⁸, and R⁹ are each independently hydrogen or a substituent selected from the group consisting of C₁-C₂₀ alkyl, C₂-C₂₀ alkenyl, C₂-C₂₀ alkynyl, aryl, C₁-C₂₀

carboxylate, C₁-C₂₀ alkoxy, C₂-C₂₀ alkenyloxy, C₂-C₂₀ alkynyloxy, aryloxy, C₂-C₂₀ alkoxycarbonyl, C₁-C₂₀ alkylthiol, aryl thiol, C₁-C₂₀ alkylsulfonyl and C₁-C₂₀ alkylsulfinyl, the substituent optionally substituted with one or more moieties selected from the group consisting of C₁-C₁₀ alkyl, C₁-C₁₀ alkoxy, aryl, and a functional group selected from the group consisting of hydroxyl, thiol, thioether, ketone, aldehyde, ester, ether, amine, imine, amide, nitro, carboxylic acid, disulfide, carbonate, isocyanate, carbodiimide, carboalkoxy, carbamate, and halogen; and,

R¹³ is C₁-C₂₀ alkyl or aryl.

19. The method as in claim 18 wherein

M is ruthenium;

X and X¹ are each chloride;

L is selected from the group consisting of -P(cyclohexyl)₃, -P(cyclopentyl)₃, -P(isopropyl)₃, and -P(phenyl)₃;

R is hydrogen;

R¹ is phenyl or -C=C(CH₃)₂;

R⁶ and R⁷ are each independently hydrogen, phenyl, or together form a cyclophenyl or cyclohexyl; and,

R⁸ and R⁹ are each independently a substituted or unsubstituted aryl.

20. The method as in claim 19 wherein R¹³ is t-butyl.

21. The method as in claim 18 wherein

M is ruthenium;

X and X¹ are each chloride;

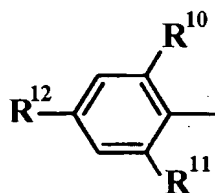
L is selected from the group consisting of -P(cyclohexyl)₃, -P(cyclopentyl)₃, -P(isopropyl)₃, and -P(phenyl)₃;

R is hydrogen;

R¹ is phenyl or -C=C(CH₃)₂;

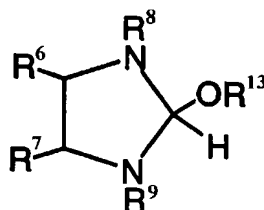
R⁶ and R⁷ together form a cycloalkyl group; and

R⁸ and R⁹ are the same and are each of the formula



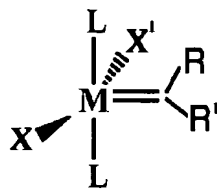
wherein

R¹⁰, R¹¹, and R¹² are each independently hydrogen, methyl, ethyl, propyl, isopropyl, hydroxyl, and halogen.



22. The method as in claim 21 wherein is optically active.

23. A method for making a metathesis catalyst comprising contacting a compound of



the formula with an imidazolidine whereby the imidazolidine replaces one of the L ligands wherein:

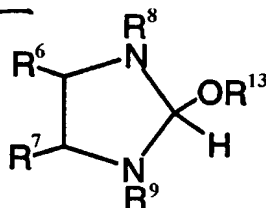
M is ruthenium or osmium;

X and X¹ are each independently an anionic ligand;

L is a neutral electron donor ligand; and,

R and R¹ are each independently hydrogen or a substituent selected from the group consisting of C₁-C₂₀ alkyl, C₂-C₂₀ alkenyl, C₂-C₂₀ alkynyl, aryl, C₁-C₂₀ carboxylate, C₁-C₂₀ alkoxy, C₂-C₂₀ alkenyloxy, C₂-C₂₀ alkynyloxy, aryloxy, C₂-C₂₀ alkoxycarbonyl, C₁-C₂₀ alkylthiol, aryl thiol, C₁-C₂₀ alkylsulfonyl and C₁-C₂₀ alkylsulfinyl, the substituent optionally substituted with one or more moieties selected from the group consisting of C₁-C₁₀ alkyl, C₁-C₁₀ alkoxy, aryl, and a functional group selected from the group consisting of hydroxyl, thiol, thioether, ketone, aldehyde, ester, ether, amine, imine, amide, nitro, carboxylic acid, disulfide, carbonate, isocyanate, carbodiimide, carboalkoxy, carbamate, and halogen.

24. The method as in claim 23 wherein the imidazolidine is formed by contacting a secondary diamine with ammonium tetrafluoroborate to form an imidazolium salt; and contacting the imidazolium salt with an alkoxide to form the imidazolidine.
25. The method as in claim 24 wherein the secondary diamine is formed by contacting a diketone with an amine to form a diimine and hydrogenating the diimine to form the secondary di-amine;
26. The method as in claim 24 wherein the alkoxide is t-butoxide.
27. The method as in claim 24 wherein the imidazolidine is of the formula



wherein

R⁶, R⁷, R⁸, and R⁹ are each independently hydrogen or a substituent selected from the group consisting of C₁-C₂₀ alkyl, C₂-C₂₀ alkenyl, C₂-C₂₀ alkynyl, aryl, C₁-C₂₀ carboxylate, C₁-C₂₀ alkoxy, C₂-C₂₀ alkenyloxy, C₂-C₂₀ alkynyloxy, aryloxy, C₂-C₂₀ alkoxy carbonyl, C₁-C₂₀ alkylthiol, aryl thiol, C₁-C₂₀ alkylsulfonyl and C₁-C₂₀ alkylsulfinyl, the substituent optionally substituted with one or more moieties selected from the group consisting of C₁-C₁₀ alkyl, C₁-C₁₀ alkoxy, aryl, and a functional group selected from the group consisting of hydroxyl, thiol, thioether, ketone, aldehyde, ester, ether, amine, imine, amide, nitro, carboxylic acid, disulfide, carbonate, isocyanate, carbodiimide, carboalkoxy, carbamate, and halogen; and,

R¹³ is C₁-C₂₀ alkyl or aryl.

28. The method as in claim 27 wherein
M is ruthenium;
X and X¹ are each chloride;

L is selected from the group consisting of -P(cyclohexyl)₃, -P(cyclopentyl)₃, -P(isopropyl)₃, and -P(phenyl)₃;

R is hydrogen; and

R¹ is phenyl or vinyl, optionally substituted with one or more moieties selected from the group consisting of C₁-C₅ alkyl, C₁-C₅ alkoxy, phenyl, and a functional group selected from the group consisting of hydroxyl, thiol, thioether, ketone, aldehyde, ester, ether, amine, imine, amide, nitro, carboxylic acid, disulfide, carbonate, isocyanate, carbodiimide, carboalkoxy, carbamate, and halogen.

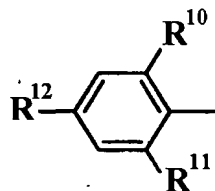
29. The method as in claim 28 wherein R¹ is phenyl or -C=C(CH₃)₂ and R¹³ is t-butoxide.

30. The method as in claim 28 wherein

R⁶ and R⁷ are each independently hydrogen, phenyl, or together form a cycloalkyl or an aryl optionally substituted with one or more moieties selected from the group consisting of C₁-C₁₀ alkyl, C₁-C₁₀ alkoxy, aryl, and a functional group selected from the group consisting of hydroxyl, thiol, thioether, ketone, aldehyde, ester, ether, amine, imine, amide, nitro, carboxylic acid, disulfide, carbonate, isocyanate, carbodiimide, carboalkoxy, carbamate, and halogen; and

R⁸ and R⁹ are each independently either substituted or unsubstituted aryl.

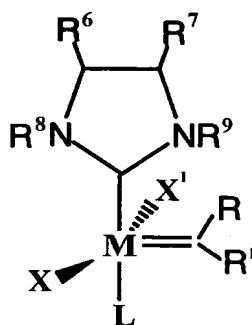
31. The method as in claim 30 wherein R⁸ and R⁹ are each is independently of the formula



wherein

R¹⁰, R¹¹, and R¹² are each independently hydrogen, methyl, ethyl, propyl, isopropyl, hydroxyl, and halogen.

32. A method for performing a metathesis reaction comprising contacting an olefin with a compound of the formula



wherein:

M is ruthenium or osmium;

X and X¹ are each independently an anionic ligand;

L is a neutral electron donor ligand; and,

R, R¹, R⁶, R⁷, R⁸, and R⁹ are each independently hydrogen or a substituent selected from the group consisting of C₁-C₂₀ alkyl, C₂-C₂₀ alkenyl, C₂-C₂₀ alkynyl, aryl, C₁-C₂₀ carboxylate, C₁-C₂₀ alkoxy, C₂-C₂₀ alkenyloxy, C₂-C₂₀ alkynyloxy, aryloxy, C₂-C₂₀ alkoxycarbonyl, C₁-C₂₀ alkylthiol, aryl thiol, C₁-C₂₀ alkylsulfonyl and C₁-C₂₀ alkylsulfinyl, the substituent optionally substituted with one or more moieties selected from the group consisting of C₁-C₁₀ alkyl, C₁-C₁₀ alkoxy, aryl, and a functional group selected from the group consisting of hydroxyl, thiol, thioether, ketone, aldehyde, ester, ether, amine, imine, amide, nitro, carboxylic acid, disulfide, carbonate, isocyanate, carbodiimide, carboalkoxy, carbamate, and halogen.

33. The method as in claim 32 wherein:

M is ruthenium;

X and X¹ are each chloride;

L is selected from the group consisting of -P(cyclohexyl)₃, -P(cyclopentyl)₃, -P(isopropyl)₃, and -P(phenyl)₃;

R is hydrogen;

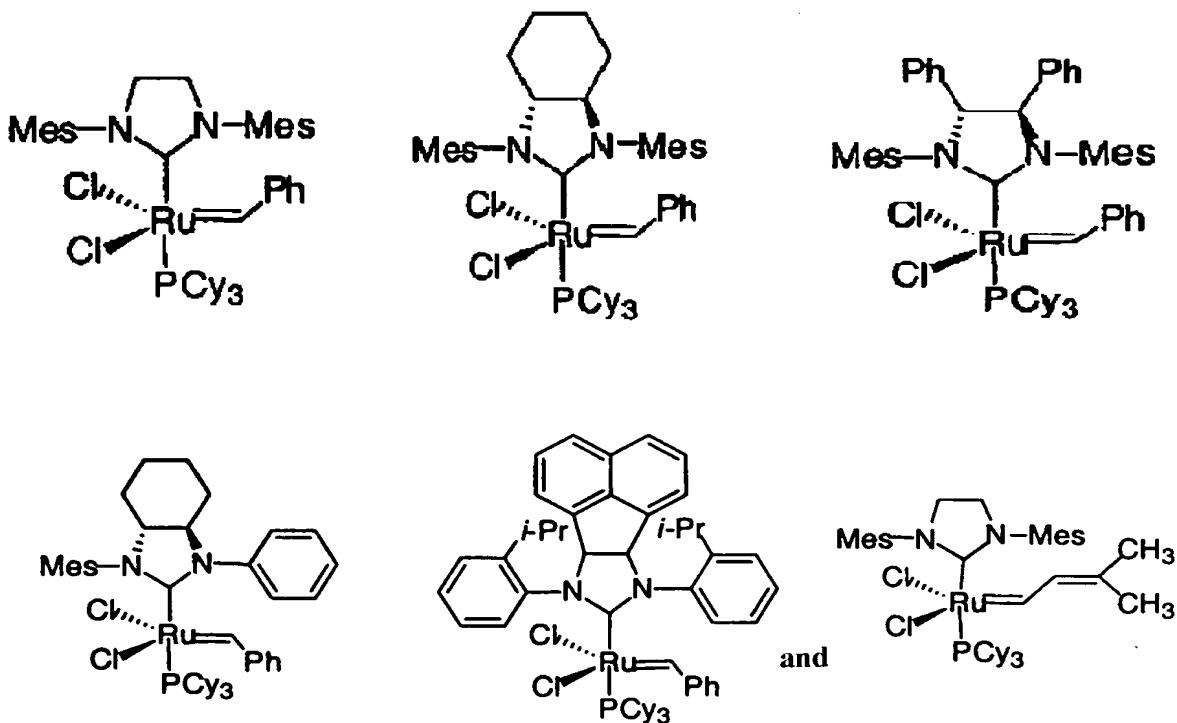
R¹ is phenyl or vinyl, optionally substituted with one or more moieties selected from the group consisting of C₁-C₅ alkyl, C₁-C₅ alkoxy, phenyl, and a functional group selected from the group consisting of hydroxyl, thiol, thioether, ketone, aldehyde, ester,

ether, amine, imine, amide, nitro, carboxylic acid, disulfide, carbonate, isocyanate, carbodiimide, carboalkoxy, carbamate, and halogen;

R^6 and R^7 are each independently hydrogen, phenyl, or together form a cycloalkyl or an aryl optionally substituted with one or more moieties selected from the group consisting of C_1 - C_{10} alkyl, C_1 - C_{10} alkoxy, aryl, and a functional group selected from the group consisting of hydroxyl, thiol, thioether, ketone, aldehyde, ester, ether, amine, imine, amide, nitro, carboxylic acid, disulfide, carbonate, isocyanate, carbodiimide, carboalkoxy, carbamate, and halogen; and

R^8 and R^9 are each is independently C_1 - C_{10} alkyl or aryl optionally substituted with C_1 - C_5 alkyl, C_1 - C_5 alkoxy, aryl, and a functional group selected from the group consisting of hydroxyl, thiol, thioether, ketone, aldehyde, ester, ether, amine, imine, amide, nitro, carboxylic acid, disulfide, carbonate, isocyanate, carbodiimide, carboalkoxy, carbamate, and halogen.

34. The method as in claim 32 wherein the compound is selected from the group consisting of



35. The method as in claim 33 wherein the olefin is a cyclic olefin.

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